SUGARCANE PRODUCTION, PROCESSING AND MARKETING IN TANZANIA

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ABSTRACT Sugarcane is one of the important food and commercial crops of Tanzania. Its production is concentrated mainly in three regions, Morogoro, Kagera and Kilimanjaro. Most of the sugar produced in the country is for home consumption and only a small proportion is exported to service foreign debts.

This paper briefly reviews the agronomic, production and marketing aspects of sugarcane in Tanzania, with special emphasis on the factors associated with variation in production during the past ten years. During the 1983/84 season, the country produced slightly over 130,000 tons of processed sugar, but 1988/89 production had dropped to just about 96,000 tons. During the 1990's (1991/92-1993/94), production increased in response to the trade liberalization policy of the country. To increase and sustain the country's future sugar production, improved soil management of sugarcane fields, irrigation technology and the use of improved clones need to be introduced. The current marketing and handling structure in the sugar industry requires reform in order to increase efficiency and reduce storage overheads paid by the consumers.

Key Words: Sugarcane; Production trends; Sustainability; Research; Tanzania.

INTRODUCTION

Sugarcane is an important commercial crop in Tanzania. It is the main source of sugar produced for both export and domestic consumption. Currently, most sugarcane is grown in estates, owned by the sugar processing factories (SPF) as well as contract growers (CG).

This paper reviews the ecology, growth characteristics, production trends during the past ten years and methods of increasing and sustaining sugarcane production in Tanzania. Processing, storage and marketing constraints facing the sugar industry in the country are discussed.

Before reviewing the sugarcane production in Tanzania, following is the statistics for world and African sugar production and marketing. The total cultivated area (area harvested) and production of sugarcane in FAO production yearbook 1994, is the least in Africa among all continents. The average yield per ha in Africa is as low as about 85% of that of the world (Table 1). In Africa, South Africa and Egypt are the major sugar producing countries with more than 15 million MT and about 12 million MT respectively. Mauritus, Sudan, Zimbabwe and Kenya also produce sugar but less than half of the foregoing countries (Table 2). In Tanzania, sugarcane pro-

Table 1. Sugarcane Production in the World (1994).

	Area harvest 10^3t	Yield t/ha	Production 10^3t
World	17606	61.1	1,075,893
Africa	1312	53.2	69,784
NC America	2755	55.2	152,084
S America	5222	68.1	355,815
Asia	7873	58.6	461,291
Others	444	83.2	36,921

(FAO Production Yearbook 1994)

Table 2. Major sugarcane producing countries in Africa.

	Area harvest 10^3t	Yield t/ha	Production 10^3t	Export 10^3t	Inport 10^3t
Egypt	115	103.4	11,900	0.9	246
Kenya	45	77.1	3,470	—	58
Mauritus	74	68	5,000	576	—
S Africa	289	54.3	15,676	52	62
Sudan	85	52.9	4,500	75	47
Zimbabwe	35	116	4,060	—	130
Tanzania	14	109.3	1,530	11	35
Zambia	12	109.4	1,311	11	0.2

(FAO Production Yearbook 1994 and FAO Trade Yearbook 1994)

duction per year is 1.5 million MT, that is almost the same as in Zambia (Table 2), and also Côte d'Ivoire, Gabon, Cameroon and Zaire in Tropical Western Africa. According to the statistics, the average yield of sugarcane in Tanzania is extremely high as in Egypt and Zimbabwe, 1.5 times larger than the world average yield (Table 1).

The total current sugarcane production in Tanzania is below the country's annual demand for the commodity. However, research carried out in the country during the past ten years shows that the country has the potential to become a net exporter of the commodity if the current constraints limiting production at the farm level were removed. A knowledge of the sugarcane growth requirements may improve management of the crop to boost production at farm level.

Sugarcane is a giant grass which belongs to the genus Saccharum. Six species are included in the classification of sugarcane. Among the species known are *officinarum, spontaneum, barberi, sinense, edule* and *robustum.* These species grow in both tropical and sub-tropical environments.

Saccharum officinarum originated in the South Pacific, most probably in New Guinea by crosses and back-crossing with the original type, *S. spontaneum*, occurring wild from Africa, India and through the Pacific to New Guinea. (Purseglove, 1974)

Penetration into Asia and Africa was accompanied by polyploidization and hybridization of the wild types to produce the noble cane *S. officinarum* with high sugar content. Selection pressure has favored improved sugar production, probably associated with profuse tillering ability for survival in harsh environments (Bull & Glasziou, 1963). Trading and local wars caused the highly prized clones of *S. officinarum* to become sparse throughout Polynesia and Southeast Asia (Parthasarathy, 1947).

Up to the end of the 19th century, only a few clones of *S. officinarum* had been used to establish the major portion of the world sugarcane industry. These clones proved susceptible to diseases, necessitating hybridization to produce disease-resistant clones. Most of the breeding work in Tanzania is carried out at Kibaha Agricultural Research Institute under the Ministry of Agriculture, Livestock Development and Cooperatives (MALDC). Sugar is an essential ingredient in food processing, both small- and large-scale in Tanzania as anywhere in the world.

ECOLOGY OF SUGARCANE

Sugarcane requires ample supply of water, 1200 - 1500 mm per annum. In freely drained soils, a high precipitation can be tolerated. The duration of the rainy season is important in sugarcane growth. For example, at the Kilombero Sugarcane Estates (Fig. 1) where annual rainfall could be as high as 1500 mm per annum, sugarcane is also irrigated because most of the rainfall is restricted to the period between March and May. Adequate moisture and temperature are the two most important ecological requirements that are essential for efficient growth and productivity of the sugarcane crop. If excess water is not immediately drained at the sprouting stage, it will result in rotting of stem cuttings called setts, usually used for the next season's plantings. On the other hand, if rainfall is insufficient during the season, supplementary irrigation becomes necessary to ensure effective development of stems. In this context, water stress occurring in the plant during stem elongation severely reduces cane pro-

Fig. 1. Farmer's sugarcane filed at Kilombero.

duction.

Like many other tropical cereal grasses, optimum temperature for sugarcane is essential for effective germination of sett, tiller elongation, photosynthate mobilization and ripening. Sugarcane growing areas in Tanzania are warm and conducive to maximum physiological activity throughout the season. According to Purseglove (1974) and Evans, the optimum temperature for germination of sugarcane is 27-33℃ while good tiller production occurs when the temperature is about 30℃. A day temperature of below 18℃ lengthens the tillering period thus resulting in uneven maturity of the canes. Stalk elongation is linearly related to temperature with an optimum at 23℃. An air temperature range of 24-30℃ and a soil temperature of around 21℃ are optimum for photosynthesis in sugarcane. Sugarcane does not grow when temperatures fall below 15℃ or rise above 38℃.

Insolation in a sugarcane plantation is controlled not only by day length and humidity, but also by cloudiness of the sky. Solar radiation is particularly important in sugarcane because absorption of mineral nutrients from the soil is enhanced by the presence of light during the day time and absorption of water from the soil is equally dependent upon solar energy. It is imperative, therefore, that the greater the exposure of sugarcane to sunlight, the greater the yield. These ecological requirements of sugarcane make Tanzania and many other tropical countries best suited for its production.

In sugarcane, close spacing increases yield per area where the growing season is short. When the growing season is long enough, proper plant arrangement in rows promotes optimum exposure to solar radiation and hence, greater production.

Sugarcane flowers when the photoperiod is conducive. It is optional to harvest sugarcane immediately before or after flowering to extract high quality sugar. If harvesting is long delayed after flowering, sugar quality would be greatly reduced. This happens mainly because the sugar stored in the stem tissues hydrolyse and transport to the inflorescence to promote development.

Sugarcane is a heavy feeder crop. The soils in which it is grown should have optimum properties. In Tanzania, sugarcane is grown mainly on loamy soils with good proportions of sand, silt and clay with good water storage and drainage characteristics. The soils are fairly fertile, thus supplementary fertilizers are used only when necessary. A pH range of 6-8 is considered optimal for sugarcane production.

SUGARCANE GROWTH AND DEVELOPMENT

The crop is usually produced from stem cuttings called setts and each node has all the qualities for growing new plants. The shoots grow from underground nodes, and the axillary buds at these nodes give rise to tillers. The number of tillers may vary from very few to a very large number, e.g. up to 144 per stool arising from one bud (Shamel, 1974).

Sett roots supply the germinating bud with water until shoot roots are formed. Root proliferation become abundant when growth conditions are optimum. Root growth ability under sub-optimum conditions for sugarcane growth is among the selection criteria in breeding programs worldwide.

Growth of sugarcane varies depending on the cropping cycle of one year or two year cycle. Whereas numerous stalks may arise from a single sett, over 50% may die before nine months of growth when stable stalks are established. Sugarcane selection for improved clones focus on effective tillering ability and rapid growth rate to maximize exposure to solar radiation. Hawaii selections, for example, are aimed at maximizing high leaf area index (LAI) within six months of growth. LAI declines slowly after the maximum has been achieved.

The adaptability of sugarcane to high temperature conditions is mainly associated with expansion rate of the leaf area. In this regard, leaf area expansion rate is more related to temperature than the solar radiation receipt during the first few months of growth. Maximum rates of leaf expansion are observed at 22℃ (Bull & Glasziou, 1975). Slow growth in the establishing stage of sugarcane seedlings is one of the limiting factors to utilize this crop in warm temperate zone as in Japan, where the optimum range of temperature for juvenile growth stage was studied by Ehara, *et al.* (1994). Their experiments concluded that 25℃-30℃ was favourable to increase the rate of emergence of leaves, and that 20℃-25℃ was favourable to increase the number of tillers during the juvenile phase. These data well support Evans's finding because the rate of leaf expansion depends primarily on the rate of leaf emergence and the rate of tillering at this phase. As a speciffic growth characteristics, it was observed that the relative growth rate (RGR) of sugarcane was much smaller than that of any other cereal crops as maize, sorghum and millets due to a much smaller leaf area ratio (LAR) in spite of a large assimilation rate (NAR) (Ehara, *et al.* 1994).

Under cooler conditions the juvenile growth phase is prolonged but that in the Tropics result in higher relative leaf area expansion rates during periods of high radiation exposure.

Total dry matter (TDM) produced by sugarcane may average 40 gm^{-2} d^{-1} and may exceed 150 t ha^{-1} $year^{-1}$ under very good growth conditions. In this regard, TDM production can be maximized by extending the growth duration (Bull & Glasziou, 1975). To utilize such a high potential for dry matter productivity, the dry matter digestibility (DMD) of sugarcane for cattle feeding was evaluated by *in vitro* cellulase method and it was found that DMD of stems increased with growth upto 77% while that of leaves remained at 50 to 55% (Takamura, *et al*. 1986). All these data suggest that sugarcane is to be utilized not only for producing sugar but also for feeding cattle feed.

SUGARCANE PRODUCTION TRENDS IN TANZANIA

Tanzania is well situated for the production of sugarcane in East Africa. The country has a wide variety of climatic and weather regimes with an area of 945,087 km^2 (Berry, 1991) and a population of over 27 million people most of whom are employed in the rural sector (80%). Apart from the high mountain areas, temperatures are not the major limiting factor to sugarcane production (Table 3-5). Rainfall may be considered the limiting factor for most crops, sugarcane inclusive. About 21% of the country can expect 90% probability of receiving slightly higher than 750 mm of rainfall and only about 3% can expect more than 1250 mm. About one-third of the country is dry (mainly the central plateau), with less than 500 mm of expected rainfall per year. During most of the year, evapotranspiration exceeds precipitation in the drier areas.

Due to seasonal rainfall shortages, sugarcane farms in Tanzania are situated along river valleys to facilitate supplementary irrigation during the season. To date, only three regions are considered suitable under the above criteria for sugarcane production, i.e., Morogoro (Kilombero & Mtibwa Valleys), Kilimanjaro (under Irrigation Scheme) and Kagera (River Kagera Basin).

There are two major sugarcane estates in Morogoro, Kilombero Sugar Company and Mtibwa Sugar Estates. These together produce over 80,000 tons of processed sugar annually (Table 3). In plate 1, sugarcane field at Kilombero is shown. In Kilimanjaro, the Tanganyika Planting Company (TPC) is one of the largest sugarcane estates in the country. Over 35,000 tons of processed sugar are produced annually (Table 4). The Kagera Sugarcane Estates are fairly small, producing only about 2,000 tons of processed sugar annually (Table 5).

Indeed, over the past ten years, sugar production in Kilimanjaro Region in the country varied greatly mainly because of both unfavorable socio-economic and environmental conditions. The major factor which caused much reduction in sugar production during the 1980's was drought, coupled with poor irrigation infrastructures in the sugar estates. During this period, sugar production in Kilimanjaro Region declined from over 40,000 tons (1983/84) to only about 26,000 tons (1989/90). During the 1990's, sugar production increased again in all estates except Kagera, where production figures generally declined (Table 3-5).

Lower sugar production statistics from Kagera could be associated with factors other than biological, since sugarcane production remained fairly stable over the years. Among such factors would be non-delivery of processed sugar to the Sugar Development Corporation (SUDECO) go downs in Dar-es-Salaam. It is possible that the sugar produced from this factory was exported to the neighboring countries (as was the case with other commercial crops in the region) or was distributed directly to unregistered retailers within the country (black marketeers, a then com-

Table 3. Sugarcane production trends in Tanzania during the past ten years[1] in Morogoro Regions.

Year	Cane Production (tons)	Area (ha)	Yield per ha (tons)	Sugar (tons)	Rain-fall (mm)	RH (%)	Daily Temperature (°C)
1983/84	914304	10084	90.67	81683	—[2]	54	30.9
1984/85	698198	10000	69.82	65393	—	55	29.7
1985/86	601885	9700	62.05	58523	—	51	—
1986/87	595467	9525	62.52	65407	—	54	30.3
1987/88	706966	10379	68.12	64621	611.4	53	30.8
1988/89	658161	9928	66.29	62150	723.9	49	30.9
1989/90	706822	10223	69.14	69489	1025.9	55	29.7
1990/91	696121	—	—	69253	1033.8	54	30
1991/92	822873	—	—	76671	—	—	—
1992/93	857503	—	—	81266	—	—	—
1993/94	942654	—	—	89967	—	—	—

1 Source: Sugar Development Corporation (SUDECO), Dar es Salaam, Tanzania.

2 Data not available.

Table 4. Sugarcane production trends in Tanzania during the past ten years[1] in Kilimanjaro Region.

Year	Cane Production (tons)	Area (ha)	Yield per ha (tons)	Sugar (tons)	Rain-fall (mm)	RH (%)	Daily Temperature (℃)
1983/84	410200	5670	72.35	41557	709.5	46	30.2
1984/85	410109	5670	72.33	37022	915.2	46	29.2
1985/86	697408	5850	119.22	37928	1085.9	48	29.0
1986/87	400238	4800	83.38	33499	1085	—	29.2
1987/88	383220	3282	116.76	35699	443.7	—	30.5
1988/89	351682	3850	91.35	31712	1075.7	—	29.8
1989/90	319361	—[2]	—	26455	789.8	—	18.8
1990/91	427687	3282	130.31	39455	1308.3	—	—
1991/92	347866	3850	90.35	32681	903.9	—	—
1992/93	392704	—	—	37750	—	—	—
1993/94	432220	—	—	37750	—	—	—

1 Source: Sugar Development Corporation (SUDECO), Dar es Salaam, Tanzania.

2 Data not available.

Table 5. Sugarcane production trends in Tanzania during the past ten years[1] in Kagera Region.

Year	Cane Production (tons)	Area (ha)	Yield per ha (tons)	Sugar (tons)	Rain-fall (mm)	RH (%)	Daily Temperature (℃)
1983/84	137530	5114	26.89	8497	—	—	—
1984/85	114840	4500	25.52	6100	2363.0	—	—
1985/86	65300	4650	14.04	3818	2333.9	79	—
1986/87	67300	5470	12.30	3889	1839.7	81	—
1987/88	21240	5570	3.81	943	2108.9	77	26.1
1988/89	33030	4800	6.88	2335	1919.5	—	25.6
1989/90	34148	—[2]	—	2558	—	—	—
1990/91	49793	—	—	2727	—	—	—
1991/92	98400	—	—	5022	—	—	—
1992/93	89300	—	—	2399	—	—	—
1993/94	49400	—	—	2200	—	—	—

1 Source: Sugar Development Corporation (SUDECO), Dar es Salaam, Tanzania.

2 Data not available.

mon phenomenon with this commodity in Tanzania). A recent study showed that official marketing statistics of commercial crops in Kagera declined while actual production at the farm level increased through cultivation of new farms and adoption of improved production innovations (Anonymous, 1994).

It is apparent from these observations that Tanzania has the potential to become self-sufficient in sugar production if the limiting factors in edaphic, biological, and socio-economic areas were holistically tackled. A system whereby small farmers could be encouraged to grow sugarcane in the periphery of the factories could spearhead a revolution in the sugar industry in the country. Indeed, most sugarcane processing plants are under-utilized due to low annual cane production.

TOWARDS SUSTAINABLE SUGAR PRODUCTION IN TANZANIA

Tanzania's major objective in sugar production is to expand sugarcane farms to meet domestic demands for the commodity and generate a surplus for export. The annual demand for sugar in Tanzania varies from 350,000 to 450,000 tons, but average annual production varies from 100,000 to 200,000 tons, resulting in an actual deficit of approximately 250,000 tons. In order to increase and sustain sugar production in Tanzania, a variety of problems have to be elucidated. They are related to edaphic, biological, husbandry, processing and marketing infrastructural conditions of the country. These factors are considered below.

I. Edaphic Factors

Edaphic factors need to be ameliorated for increasing sugarcane production, such as unreliable seasonal rainfall and poor irrigation in the sugarcane fields resulting in salinification of soils. The possible solution for problems would be to improve sugarcane production technologies, particularly in the management of irrigation water and the soils. Soil amelioration measures, such as fallowing and adopting leguminous species as fallow crops could improve productivity in the long run.

Sugarcane plantations should be well designed in such manner that drainage systems can be constructed and rotational systems instituted. This approach will steer the sugarcane estates from monocropping to crop diversification. Similarly, contract growers need to be educated on effective methods of managing irrigated soils to avoid reductions in yield and quality after successive seasons.

II. Biological Factors

Biological constraints associated with low productivity of sugarcane farms should also be ameliorated. Low-yield clones still dominate most sugarcane estates in Tanzania. These clones are also susceptible to pests and diseases, such as the chaffer grub and leaf rusts, which reduce sugarcane yield and quality of the processed sugar. As a solution to these problems, crop research should be strengthened. International clones, such as those bred in Hawaii, could be tested for adaptability to Tanzanian climate and soil as a way of improving sugarcane yield. There is, therefore, a need for the sugarcane industry in the country to develop independent research units within estates to service production and processing requirements of the crop. The current dependency of the industry on the research and training institutes (RTIs) for improved technologies may subscribe to the slow growth. Such independent research units have to be funded directly by the industry to ensure sustainability of their activities. Some estates already have research units in operation but with the lack of both trained workmanship and equipment.

III. Sugarcane Husbandry

Sugarcane factories with contract growers and even the large-scale estates often have poor crop husbandry practices. Most farmers employ obsolete technology in sugarcane production, e.g., lack of pest control such as for rats and the use of fire before cane cutting. These aspects do not only reduce overall sugar production but also reduce quality of the sugar produced. Better methods of harvesting need to be developed and instituted to ensure improved sugar quality. Research should develop better methods of handling canes prior to harvesting. Successful techniques have been developed elsewhere, but they need to be tested under local condition. Such techniques include, use of clones which shed leaves readily towards maturity, and application of plant growth regulators (PGR) to stimulate and accelerate leaf senescence and defoliation towards maturity.

IV. Processing Facilities

Whereas production capacity of the sugarcane estates may determine real increases in sugar production in the country, processing facilities require rehabilitation and modernization. Most machines used for processing sugarcane are old and generally crude in performance. The old sugarcane estates such as those in Kilimanjaro (TPC) still use machines introduced before the 1960’s by foreign farmers. Although the company produces the best quality sugar in the country, it is difficult to maximize efficiency with such old machines. Apart from being old, most of these machines are also under-utilized because of low cane production. There are frequent sugar shortages during the year mainly because the factories have to be closed momentarily for major repairs and also to await maturity of new season canes. A sequential planting system coupled with improved machinery should ensure continuous supply of sugar in the country. Major water conservation schemes should be introduced to improve efficiency of the irrigation systems. Water should be effectively recycled within the farms to avoid wastage.

V. Marketing Infrastructure

The sugar market was monopolized by SUDECO prior to trade liberalization in Tanzania. Due to the liberalized marketing structure of agricultural commodities, a large proportion of the sugar is purchased and merchandised by local as well as foreign entrepreneurs. Some socio-economic problems arose from the trade liberalization in the country linked with low production. At given times of the year, sugar is either exported illegally or hoarded by vendors to create artificial shortages. When hoarding is coupled with low supply and high demand, the prices of the commodity become “sky-high.” Before the 1990’s, for example, the price of sugar was well below T.shs 100 (US$ 0.25) per kg, but by 1993/94 it reached a peak of T.shs 800 to 1000 (US$ 1.60-2.00) per kg. The main reason for this price increase was due to hoarding by vendors after the factories shut down for annual repairs. Even after the factories began producing again, the price of sugar stood at T.shs 450 (US$ 1.00) to 600 (US$ 1.20) per kg, depending on the town. In the remote villages, the commodity price is determined by the local vendor, usually it is higher than that at the nearby town. Sugar therefore, is accessed only by a small proportion of the population, mainly town dwellers and salaried employees. With increased prices, availability of sugar appears not to meet demand because only a few people can purchase it.

Some factories even talk of blocking importation of sugar in the understanding that production had artificially surpassed demand. If the price would not be checked by some authorized body, sugar will remain inaccessible to the majority of Tanzanians whose income is far below T.shs 120,000 (US$ 240.00) per annum.

VI. Storage Facilities

The current sugar shortage in the country is not only associated with low production in the factories but also insufficient storage facilities during the peak production season. Lack of storage facilities in the factories cause imbalances in sugar distribution to the regions. In most cases, sugar-producing regions such as Morogoro, Kilimanjaro and Kagera have greater shortages of the commodity than the non-producing ones, such as Dar-es-Salaam. The main reason is that all the sugar produced from the various factories has to be transported to Dar-es-Salaam for storage and distribution to the various regions, including the producers (MALDC, 1986). During off-season, sugar prices in the country go up to meet administrative and storage costs in Dar-es-Salaam. In order to avoid these unnecessary costs, storage facilities should be built in all regions. Sugar is stored by vendors who may as well get the commodity directly from the factory. Procurement of regional quotas should be made directly from the nearest factory. This would greatly reduce sugar-handling and storage overheads for the rural consumers. It should be noted, however, that this problem is diminishing following liberalization of trade in Tanzania as discussed above.

CONCLUSION

Sugarcane production in Tanzania has shown a clear declining trend during the mid-1980's. However, annual production figures started to increase again during the early 1990's, mainly in response to the favorable economic situation in the country following trade liberalization. The prices of agricultural commodities, sugar inclusive, have increased sharply. More farmers have entered into the "contract grower" system of the sugar factories due to better prices of canes. Increased number of contract growers of sugarcane has greatly contributed to the observed increase in production of processed sugar during the 1990's in all factories but Kagera Region.

Despite the observed increase in sugar production in Tanzania, the commodity will remain out of reach of the majority of the population with very low income, particularly the rural farmers. It is recommended that the price of ex-factory sugar price be reviewed by an authorized body to reduce consumer prices where possible until such a time that increased supply would favorably regulate the price of the commodity.

Indeed, sustainable sugar production in the country will depend on improved production technology, marketing and storage infrastructures at factories and regional centers. The current marketing infrastructure is laden with exorbitant storage overheads which have to be paid by the end-consumers. Similarly, there is a need to strengthen research in the sugarcane industry to ensure availability of high-yielding, disease-and-pest resistant clones which are adapted to the Tanzanian soil and climate conditions.

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